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INFLUENCE OF SPACING ON PRODUCTIVITY IN SINGLE-EAR AND PROLIFIC TYPES OF CORN.

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SINGLE-EAR AND PROLIFIC TYPES OF CORN.

Throughout the southern portion of the United States both the single-ear and prolific types of corn are more or less commonly grown. The distinguishing characters of the single-ear type are the usual production of but one well-developed ear per stalk (Figs. 1 and 2), large ears with numerous rows of kernels, and large cobs (Fig. 3). Under very favorable conditions two well-developed ears may be produced, but ordinarily secondary ears are stubby in appearance and classed as nubbins. In no variety, so far as known, is there a complete inhibition of secondary ears. As contrasted with the single-ear type, the prolific is distinguished by the normal production of more than one ear per stalk (Figs. 4 and 5). The ears usually are smaller and more slender, with fewer rows of kernels and smaller cobs (Fig. 6).

The demarcation between the two types is not absolute. Between the two extremes varieties occur that are more or less intermediate and that can not be placed accurately in either class. In each type there are occasional plants that vary toward the opposite type. By the selection of seed from such individuals it would be possible to segregate a prolific strain from the single-ear type or a single-ear strain from the prolific.

It is reasonable to assume that the development of the single-ear type has resulted from a more or less continuous selection toward a large ear. With this there has developed a tendency toward a high number of rows of kernels, large cobs, the suppression of extra shoots, and the development of but one ear per stalk. In the development of the prolific type the characters that have been perpetuated and intensified are the production of more than one ear per stalk and of small slender ears with usually a low number of rows of kernels and small cobs. It seems probable that in the single-ear type the char-

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acter of one ear per stalk has become more or less stabilized, whereas the character of weight of ear has remained in a more variable condition. In the prolific type the number of ears per plant doubtless would be a more variable character than weight of ear.

Although both the size of ear and the number of ears per stalk are limited by heredity, their expression will be determined largely by

FIG. 1.—Typical single-ear plant of corn. Height, 11 feet.

FIG. 2.—Typical single-ear plant of corn. Height, 6 feet 3 inches. Although not so tall, this plant was later in maturing and produced a larger ear and apparently as much foliage as the plant shown in Figure 1.

their environment. Other things being equal, the productiveness of the plants will be determined by their spacing. On land of uniform fertility the productiveness of the plant will tend to be in direct proportion to the area of land it occupies. In these experiments the spacings have provided a range of approximately 3 to 30 square feet per plant. The reaction of the varieties, as revealed in total yields,

production per plant, average weight of ear, and number of ears per plant, has been determined and the results tabulated. As the area per plant is increased it is obvious that an increase in production per plant will be either through an increase in the weight of the ear or an increase in the number of ears, or both.

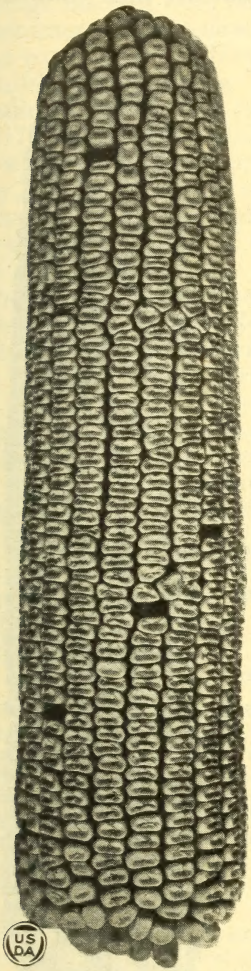

FIG. 3.—Large single-ear type of ear of corn, 12 inches long with 20 rows of kernels; weight (air-dried), 22 ounces.

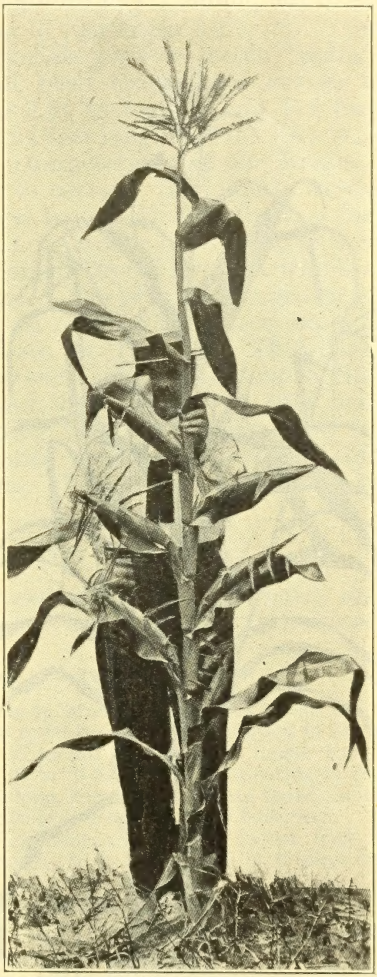

FIG. 4.—A prolific plant of corn having numerous ears but no suckers. Height, 8 feet 10 inches.

If the development of the single-ear type has been along the lines suggested, the greatest response to better environment would be an increase in the weight of the ear, with the production of more ears per plant as a secondary response. In the prolific type the greatest response to better environment would be an increase in the number of ears per plant, with increased size of ear as a secondary response.

As both types are grown extensively, it is of agronomic interest to know which yields more efficiently under ordinary field conditions

where the production of the plants is likely to be influenced by irregularity of stand and by inequalities in germination, soil, and growing conditions. The purpose of the present investigation was to study the reaction of these types under conditions that provided a wide range in the environment, obtained in this case by altering the spacing of the plants. The results should indicate their comparative values.

FIG 5.—A typical prolific plant of corn that has produced both ears and suckers. Height, 10 feet 6 inches.

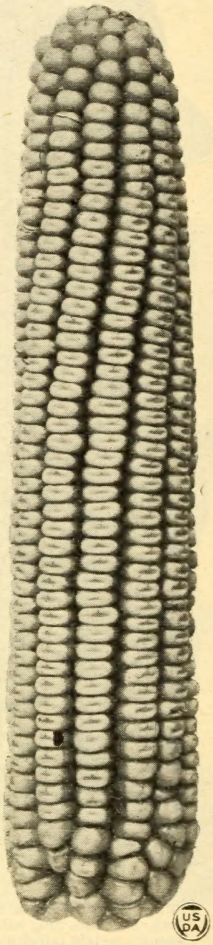

FIG. 6.—Prolific type of ear of corn, 9 inches long with 12 rows of kernels; weight (air-dried), 12 ounces.

LOCATION AND PLAN OF THE EXPERIMENTS.

The experiments were located at Clarksdale, Miss., at Waco and San Antonio, Tex., and at the Arlington Experiment Farm, Rosslyn, Va.

The plan of the experiments was to grow both types of corn at different spacings to determine which would show the greater adaptability, judged by its yield. In the experiments conducted in Missis-

sippi and Texas the varieties were planted in drills; in those at the Arlington Experiment Farm the plantings were in hills.

The corn was planted more thickly than required, and when the plants were 6 to 8 inches tall they were thinned to the spacing desired. The spacings were controlled in the drill plantings by varying the distance between individual plants in the row, whereas in the hill plantings the hills were uniformly spaced and the stand was controlled by thinning to the desired number of plants per hill.

The experimental plats at Clarksdale were on fertile "delta" land of uniform appearance that had been cropped to cotton in the preceding years. The rows were 3.89 feet apart and 211 feet long in 1917, and 3.49 feet apart and 104 feet long in 1918. At Waco the plat was on uniform sandy soil, characteristic of the Brazos River valley, cropped the previous year to cotton. The plants were grown in rows 3.15 feet apart and 100 feet long. At San Antonio the plats were on black upland of uniform appearance during the entire three years of the experiment. The corn occupied land on which cotton had been grown the preceding year. The plants were grown in rows 4.1 feet apart and 132 feet long in each of the three experiments. At the Arlington Experiment Farm in 1917 and 1918 the plats were on upland of uniform appearance. The plat used in 1917 had been in sod the previous year, and the plat used in 1918 had been cropped to soy beans the preceding year. The plats used in 1919 and 1920 were on uniform reclaimed river land on which corn had been grown in the preceding years. The plants were grown in hills 3.3 feet apart in each direction.

DESCRIPTION OF THE VARIETIES.

The single-ear type was represented by four varieties and the prolific type by three varieties. These varieties are listed and described as follows:

SINGLE-EAR VARIETIES.

U. S. Selection 120, white dent, ears 7½ to 9½ inches long, kernels broad, indentation smooth to slightly rough, 12 to 14 rows, 60 to 65 days from germination to flowering.

Singleton, strawberry dent, ears 8 to 10 inches long, kernels longer than broad, indentation slightly rough, 16 to 20 rows, 65 to 70 days from germination to flowering.

Wilson, yellow dent, ears 8½ to 11 inches long, kernels longer than broad, indentation smooth to rough, 18 to 22 rows, 55 to 65 days from germination to flowering.

Delaware White-Cap, white-capped yellow dent, ears 8 to 10 inches long, kernels longer than broad, indentation slightly rough, 18 to 24 rows, 60 to 70 days from germination to flowering.

PROLIFIC VARIETIES.

Cocke Prolific, white dent, ears slender, 7 to 8½ inches long, indentation smooth, 10 to 14 rows, 65 to 75 days from germination to flowering.

Arlington Prolific, white dent, ears slender, 7½ to 8 inches long, indentation smooth, 12 to 16 rows, 65 to 70 days from germination to flowering.

Biggs Seven-Ear, white dent, ears slender, 7 to 8½ inches long, indentation smooth, 10 to 14 rows, 60 to 70 days from germination to flowering.

RESULTS OF THE EXPERIMENTS.

Data from the experiments conducted at Clarksdale, Miss., in 1917 and 1918 are shown in Table 1. The prolific outyielded the single-ear type at every spacing. Using the results obtained at the closest spacing in each experiment as bases for calculating the relative gains made as the spacing increased, there is a total of seven comparisons between the two varieties. In these, the single-ear type

made a greater relative gain in yield per plant four times, in the weight of ear seven times, and in the number of ears per plant once.

TABLE 1.—*Influence of spacing on yield, weight of ear, and number of ears per plant in single-ear and prolific types of corn*[1] *grown at Clarksdale, Miss., in 1917 and 1918.*

Year.	Area occupied per plant (square feet).		Number of plants per row.		Weight of dry ear corn (pounds).						Number of ears per plant.		Number of suckers per plant.	
					Yield.				Average per ear.					
					Per row.		Per plant.							
	Single ear.	Prolific.	Single ear.	Prolific.	Single ear.	Prolific.	Single ear.	Prolific.	Single ear.	Prolific.	Single ear.	Prolific.	Single ear.	Prolific.
1917..	4.04	3.97	203	207	71.2	88.2	0.351	0.426	0.419	0.434	0.84	0.98	0.03	0.11
	6.06	6.36	135	129	74.8	84.8	.554	.657	.562	.511	.99	1.29	.06	.22
	8.30	7.96	99	103	73.6	88.0	.743	.854	.657	.515	1.13	1.66	.37	.36
	11.73	12.06	70	68	58.2	76.4	.831	1.124	.693	.616	1.20	1.82	.14	.25
	13.45	13.69	61	60	44.2	60.6	.725	1.010	.691	.594	1.05	1.70	.06	.18
1918..	6.05	6.15	60	59	16.0	23.2	.267	.393	.348	.318	.767	1.236	0	.08
	7.72	7.72	47	47	16.0	20.6	.340	.438	.400	.312	.851	1.404	.04	.13
	11.00	10.37	33	35	14.0	26.4	.424	.754	.438	.383	.970	1.971	.15	.57
	17.28	17.28	21	21	15.0	17.6	.715	.838	.469	.400	1.524	2.095	.86	1.81

[1] The varieties used in 1917 were, U. S. Selection 120 (single ear) and Cocke (prolific); in 1918, Singleton (single ear) and Arlington (prolific).

The data obtained from the experiment conducted at Waco, Tex., are shown in Table 2. Owing to a severe drought, the yields in this plat were negligible. The tabulated results are of interest chiefly because they show that under these adverse conditions the small-eared prolific type produced more efficiently and actually made heavier ears than the single-ear type.

TABLE 2.—*Influence of spacing on yield, weight of ear, and number of ears per plant in single-ear (Singleton) and prolific (Arlington) types of corn grown at Waco, Tex., in 1918.*

Year.	Area occupied per plant (square feet).		Number of plants per row.		Weight of dry ear corn (pounds).						Number of ears per plant.		Number of suckers per plant.	
					Yield.				Average per ear.					
					Per row.		Per plant.							
	Single ear.	Prolific.	Single ear.	Prolific.	Single ear.	Prolific.	Single ear.	Prolific.	Single ear.	Prolific.	Single ear.	Prolific.	Single ear.	Prolific.
1918...	3.45	3.28	91	96	0.6	1.2	0.007	0.012	0.067	0.085	0.099	0.146	.....	0
	6.43	7.00	49	45	4.0	4.0	.082	.086	.143	.143	.572	.622	0.02	0.04
	10.50	10.85	30	29	4.6	7.2	.153	.248	.184	.218	.834	1.138	.03	0
	15.75	15.00	20	21	2.6	7.2	.130	.343	.144	.257	.900	1.334	.05	0

In Table 3 are recorded the data from the experiments conducted at San Antonio, Tex., in 1918, 1919, and 1920. The prolific out-yielded the single-ear variety in 14 out of 16 comparisons. A comparison of the two varieties as to relative gains as the spacing increased, based on the results obtained at the closest spacing in each experiment, show that in 13 comparisons the single-ear type made greater gains once in yield per plant, seven times in the weight of ear, and four times in the number of ears per plant.

TABLE 3.—*Influence of spacing on yield, weight of ear, and number of ears per plant in single-ear (Singleton) and prolific (Arlington) types of corn grown at San Antonio, Tex., in 1918, 1919, and 1920.*

Year.	Area occupied per plant (square feet).		Number of plants per row.		Weight of dry ear corn (pounds).						Number of ears per plant.		Number of suckers per plant.	
					Yield.				Average per ear.					
					Per row.		Per plant.							
	Single ear.	Prolific.	Single ear.	Prolific.	Single ear.	Prolific.	Single ear.	Prolific.	Single ear.	Prolific.	Single ear.	Prolific.	Single ear.	Prolific.
1918	4.10	4.67	132	116	59.3	54.0	0.449	0.465	0.468	0.377	0.96	1.23	0	0.090
	6.20	5.87	85	92	45.7	46.7	.538	.508	.508	.459	1.06	1.11	.030	0
	8.00	8.00	68	68	41.2	56.2	.606	.826	.570	.434	1.06	1.90	.130	.190
	14.70	14.00	37	39	32.8	45.0	.886	1.155	.548	.489	1.62	2.36	.190	.180
	15.86	16.58	34	33	27.2	34.8	.800	1.055	.542	.407	1.48	2.59	.260	.180
	20.50	19.50	26	28	18.7	32.0	.720	1.142	.514	.353	1.40	3.24	0	.860
1919	8.32	8.46	65	64	38.7	44.6	.596	.697	.536	.421	1.108	1.656	.038	0
	12.01	12.59	45	43	31.1	37.5	.692	.872	.520	.441	1.333	1.975	0	.046
	14.62	14.24	37	38	25.3	34.2	.684	.901	.495	.463	1.378	1.949	.081	.053
	16.92	16.40	32	33	23.7	28.8	.741	.874	.485	.400	1.530	2.180	.031	.091
	21.61	22.52	25	24	16.0	23.1	.640	.960	.446	.435	1.440	2.210	.042	0
1920	4.51	4.62	120	117	44.0	43.1	.367	.368	.380	.323	.97	1.14	.083	.026
	8.48	8.48	64	64	34.8	39.3	.544	.614	.536	.397	1.02	1.55	.031	.078
	9.84	10.40	55	52	29.3	38.3	.533	.736	.524	.408	1.02	1.81	.291	.192
	12.60	12.60	43	43	27.5	28.7	.640	.668	.540	.384	1.19	1.75	.140	.465
	18.00	18.00	30	30	19.2	27.8	.640	.927	.469	.392	1.37	2.37	.133	.333

TABLE 4.—*Influence of spacing on yield, weight of ear, and number of ears per plant in single ear and prolific types of corn grown at the Arlington Experiment Farm, Rosslyn, Va., in 1917, 1918, 1919, and 1920.*[1]

Year.	Number of hills.		Number of plants per hill.		Area occupied per plant (square feet).		Weight of dry ear corn (pounds).						Number of ears per plant.		Number of suckers per plant.	
							Yield.				Average per ear.					
							Per hill.		Per plant.							
	Single ear.	Prolific.	Single ear.	Prolific.	Single ear.	Prolific.	Single ear.	Prolific.	Single ear.	Prolific.	Single ear.	Prolific.	Single ear.	Prolific.	Single ear.	Prolific.
1917	20	17	4	4	2.72	2.72	1.720	1.890	0.430	0.472	0.454	0.287	0.95	1.65	0.012	0
	20	20	3	3	3.63	3.63	1.500	1.562	.500	.521	.517	.292	.96	1.78	0	0
	21	26	2	2	5.45	5.45	1.362	1.548	.681	.774	.651	.338	1.05	2.29	.095	.019
	23	27	1	1	10.90	10.90	.891	.940	.891	.940	.732	.343	1.21	2.74	.348	.553
1918	30	38	4	4	2.72	2.72	.883	1.010	.221	.252	.268	.241	.82	1.05	.035	0
	37	38	3	3	3.63	3.63	1.017	.977	.339	.326	.372	.283	.91	1.15	0	.050
	28	40	2	2	5.45	5.45	1.017	1.025	.509	.513	.518	.315	.98	1.62	.035	.100
	39	39	1	1	10.90	10.90	.813	.920	.813	.920	.773	.421	1.05	2.18	.025	0
1919	37	29	4	4	2.72	2.72	1.960	1.960	.490	.490	.475	.304	1.03	1.61	.027	.138
	33	32	3	3	3.63	3.63	1.770	1.850	.590	.616	.590	.331	1.00	1.87	.033	.094
	40	35	2	2	5.45	5.45	1.392	1.717	.696	.858	.705	.364	.99	2.36	0	0
	38	34	1	1	10.90	10.90	.728	1.245	.728	1.245	.655	.399	1.10	3.12	.052	0
1920	22	39	4	4	2.72	2.72	1.836	2.020	.459	.505	.470	.332	.98	1.51	.091	.026
	31	34	3	3	3.63	3.63	1.354	1.620	.451	.540	.483	.326	.93	1.66	.581	.176
	36	39	2	2	5.45	5.45	1.233	1.764	.617	.882	.510	.391	1.21	2.26	1.333	.462
	33	39	1	1	10.90	10.90	.836	1.253	.836	1.253	.613	.394	1.35	3.18	1.333	.898

[1] In 1917, 1918, and 1919 the single-ear variety was the Wilson, and in 1920 it was the Delaware White-Cap. Biggs Seven-Ear was the prolific variety used in each of the four years.

The data from the experiments at the Arlington Experiment Farm, Rosslyn, Va., from 1917 to 1920 are recorded in Table 4. The figures in the columns "Number of plants per hill" represent the actual number in each hill and not a calculated average. In 16 comparisons the prolific outyielded the single-ear type 14 times and tied once. A comparison of the two types, based on the results obtained at the closest spacing in each experiment, shows that in 12 comparisons the single-ear type made the greater gain five times in yield per plant, eleven times in weight of ear, and once in the number of ears per plant.

ANALYSIS OF THE YIELDS.

A summary of the results of the nine experiments conducted at Clarksdale, San Antonio, and at the Arlington Experiment Farm shows that in a total of 41 comparisons of yield per plant the prolific exceeded the single-ear type 38 times, tied once, and was exceeded twice. In the number of ears per plant the prolific led in every comparison, whereas in the weight of ear the single-ear type led in every comparison. In a total of 32 comparisons the prolific exceeded the single-ear type 22 times in the relative gain in yield per plant, 26 times in the relative gain in number of ears per plant, and 7 times in the relative gain in the weight of ear.

Three of the comparisons in which the single-ear type made relatively greater gains than the prolific in number of ears per plant and four of the comparisons in which it made relatively smaller gains than the prolific in the weight of ear occurred at San Antonio in 1919. In these experiments the single-ear type showed a marked tendency to produce more than one ear per plant and showed losses in the weight of ear as the spacing increased, producing its heaviest ear at the closest spacing. This was the only instance in the experiments that the single-ear type reacted in this manner.

The average yield per plant, the weight of ear, and the number of ears per plant of the two types in the nine experiments are given in Table 5.

TABLE 5.—*Average yield per plant, weight of ear, and number of ears per plant in nine experiments at Clarksdale, Miss., San Antonio, Tex., and Rosslyn, Va.*

Type.	Weight of dry ear corn (pound).		Number of ears per plant.
	Yield per plant.	Yield per ear.	
Single ear	0.536	0.514	1.04
Prolific	.640	.388	1.65

These averages of the results of the nine experiments again indicate that an increase in the number of ears per plant has been more effective than an increase in the weight of ear in increasing the yield per plant.

Considering the nine experiments as a unit, the yields of both types at each of the first four spacings are compared on a ratio basis in Table 6. The relative yields within each type at the different spacings are shown in the same table on a basis of 100 for the yields at the closest spacing.

TABLE 6.—*Ratio of total yields of single-ear and prolific types of corn at each of four spacings on a basis of 100 for the single-ear type and relative yields within each type on a basis of 100 for the closest spacing, all years and at all stations.*

Spacing.	Stand (number of plants) per acre.	Ratio of yields.		Relative yields within each type.	
		Single ear.	Prolific.	Single ear.	Prolific.
First	11,820	100	110	100	100
Second	8,523	100	113	88	90
Third	6,034	100	132	80	96
Fourth	3,098	100	129	68	77

The larger yields of the prolific type indicate its better adjustment to variations in stand. Both types gave their maximum yields at the closest spacings. As the spacing increases, the yields of the single-ear type decrease more rapidly than those of the prolific and reach a considerably lower minimum.

The extreme variation in ear weight and in the number of ears per plant of both types for the nine experiments is shown in Table 7.

TABLE 7.—*Extreme variation in weight of ear and in number of ears per plant in single-ear and prolific types of corn on a basis of 100 for each of the minima.*

Type.	Weight of ear.		Number of ears per plant.	
	Minimum.	Maximum.	Minimum.	Maximum.
Single ear	100	289	100	211
Prolific	100	255	100	331

TABLE 8.—*Number of experiments in which the relative gains in the weight of ear either exceed or are less than the relative gains in the number of ears per plant in single-ear and prolific types of corn, showing also the average gains expressed in percentages of the results obtained at the closest spacing.*

Rate of spacing.	Total number of experiments.	Number of experiments in which the gains in the weight per ear—				Average gains expressed in percentages of the results at the closest spacing.			
		Exceed the gains in the number of ears per plant.		Are less than the gains in the number of ears per plant.		Single ear.		Prolific.	
		Single ear.	Prolific.	Single ear.	Prolific.	Weight of ear.	Number of ears per plant.	Weight of ear.	Number of ears per plant.
Second	9	7	2	2	7	19.4	6.4	10.1	15.0
Third	[1]9	6	0	2	9	37.2	17.0	19.7	49.8
Fourth	9	5	0	4	9	52.0	41.0	29.3	79.1
Fifth	4	1	0	3	4	21.7	37.5	15.2	81.5

[1] The relative gains in the weight of ears and in the number of ears per plant in the single-ear type were equal in one experiment.

In the single-ear type there was a greater range in the weight of ear than in the number of ears per plant. In the prolific type the range of variation was greater in the number of ears per plant than in

the weight of ear. The ear showed greater variability in weight in the single-ear type, whereas the number of ears per plant was more variable in the prolific type.

In Table 8 the experiments have been classified to show in percentage form the relation of increase in the weight of ear to increase in the number of ears per plant. The percentages are based on the performance of each type at the closest spacing. In general, the experimental evidence supports the assumptions made earlier in this bulletin as to the reaction of the two types of corn to a better environment.

CONCLUSIONS.

In these experiments the prolific type has been more productive than the single-ear type.

The prolific type has been more efficient than the single-ear type in increasing the yield per plant and in increasing the number of ears per plant. In increasing the weight of ear the single-ear type has been more efficient. Increasing the number of ears per plant has been more effective in increasing the yield per plant than has increasing the weight of ear.

The experiments indicate that in sections to which both types are adapted the prolific would be the more productive type under the conditions of general field culture because of its better adjustment to varying conditions.

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